Claims

1. A mass spectrometer comprising:

a first electric field region; and

a Time of Flight mass analyser comprising an extraction or acceleration region;

wherein in a mode of operation a group of ions having substantially different mass to charge ratios is arranged to pass through said first electric field region, wherein a first electric field which varies with time is applied across at least a portion of said first electric field region such that at least some ions having substantially different mass to charge ratios are arranged to arrive at said extraction or acceleration region at substantially the same first time.

2. A mass spectrometer as claimed in claim 1, wherein at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or substantially 100% of the ions in said group of ions are arranged to arrive at said extraction or acceleration region at substantially said same first time.

3. A mass spectrometer as claimed in claim 1, wherein said group of ions have a range of mass to charge ratios and wherein said range is at least 10, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 5500, 6000, 6500, 7000, 7500, 8000, 8500, 9000, 9500 or 10000 mass to charge ratio units.

4. A mass spectrometer as claimed in claim 1, wherein at least 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or substantially 100% of said ions arriving at said extraction or acceleration region at substantially said same first time are subsequently extracted or accelerated from said extraction or acceleration region.

5. A mass spectrometer as claimed in claim 1, wherein in use at least some ions having a first mass to charge ratio enter said first electric field region with a first initial velocity and exit said first electric field region with a first final velocity and wherein in use at least some ions having a second different mass to charge ratio enter said first electric field region with a second initial velocity and exit said first electric field region with a second final velocity, wherein said first initial velocity is greater than said second initial velocity and said first final velocity is less than said second final velocity.

6. A mass spectrometer as claimed in claim 1, wherein ions having different mass to charge ratios enter in use said first electric field region with various initial velocities and exit said first electric field region with various final velocities, and wherein the ions having the fastest initial velocities are the ions which have the slowest final velocities.

7. A mass spectrometer as claimed in any claim 1, wherein ions having different mass to charge ratios enter in use said first electric field region with various initial velocities and exit said first electric

field region with various final velocities, and wherein the ions having the slowest initial velocities are the ions which have the fastest final velocities.

8. A mass spectrometer as claimed in claim 1, wherein in use at least some ions having different mass to charge ratios enter said first electric field region with a first range of velocities and exit said first electric field region with a second range of velocities, wherein said second range of velocities is substantially smaller than said first range of velocities.

9. A mass spectrometer as claimed in claim 1, wherein ions having a first mass to charge ratio exit said first electric field region before ions having a second mass to charge ratio, wherein said first mass to charge ratio is smaller than said second mass to charge ratio.

10. A mass spectrometer as claimed in claim 1, wherein said first electric field causes ions having a first mass to charge ratio to exit said first electric field region at a first velocity and ions having a second mass to charge ratio to exit said first electric field region at a second velocity.

11. A mass spectrometer as claimed in claim 10, wherein said second mass to charge ratio is greater than said first mass to charge ratio.

12. A mass spectrometer as claimed in claim 10, wherein said second velocity is greater than said first velocity.

13. A mass spectrometer as claimed in claim 12, wherein said second velocity is < 1%, 1-5%, 5-10%, 10-15%, 15-20%, 20-25%, 25-30%, 30-35%, 35-40%, 40-45%, 45-50%, 50-55%, 55-60%, 60-65%, 65-70%, 70-75%, 75-80%, 80-85%, 85-90%, 90-95% or 95-100% greater than said first velocity.

14. A mass spectrometer as claimed in claim 12, wherein said second velocity is 100-200%, 200-300%, 300-400%, 400-500%, 500-600%, 600-700%, 700-800%, 800-900%, 900-1000%, 1000-2000%, 2000-3000%, 3000-4000%, 4000-5000%, 5000-6000%, 6000-7000%, 7000-8000%, 8000-9000%, 9000-10000% or > 10000% greater than said first velocity.

15. A mass spectrometer as claimed in claim 10, wherein said second velocity is substantially equal to said first velocity.

16. A mass spectrometer as claimed in claim 1, wherein in use said first electric field causes undesired ions to arrive at said extraction or acceleration region at a second different time.

17. A mass spectrometer as claimed in claim 16, wherein at least some of said undesired ions arriving at said extraction or acceleration region at said second different time are not subsequently extracted or accelerated into said extraction or acceleration region.

18. A mass spectrometer as claimed in claim 16, wherein said undesired ions comprise matrix, background or interference ions.

19. A mass spectrometer as claimed in claim 1, wherein at least some of said ions having substantially different mass to charge ratios arriving at said extraction or acceleration region at substantially said same first time also arrive at substantially the same position or location within said extraction or acceleration region at said same first time.

20. A mass spectrometer as claimed in claim 1, wherein said first electric field region is arranged between at least a first electrode and a second electrode, and wherein the potential of either said first electrode and/or said second electrode is varied in use with time.

21. A mass spectrometer as claimed in claim 20, wherein said first electrode comprises one or more tubular electrodes and/or one or more plate electrodes and/or one or more grid electrodes.

22. A mass spectrometer as claimed in claim 20, wherein said second electrode comprises one or more tubular electrodes and/or one or more plate electrodes and/or one or more grid electrodes.

23. A mass spectrometer as claimed in claim 20, wherein said first electrode and/or said second electrode comprises: (i) one or more annular electrodes; (ii) one or more Einzel lens arrangements comprising three or more electrodes; (iii) one or more segmented rod sets; (iv) one or more quadrupole, hexapole, octapole or higher order rod sets; or (v) a plurality of electrodes having apertures through which ions are transmitted in use.

24. A mass spectrometer as claimed in claim 1, further comprising one or more electrodes arranged within said first electric field region, wherein the potential of at least one of said one or more electrodes is varied in use with time.

25. A mass spectrometer as claimed in claim 24, wherein said one or more electrodes comprises: (i) one or more tubular electrodes; (ii) one or more annular electrodes; (iii) one or more Einzel lens arrangements comprising three or more electrodes; (iv) one or more segmented rod sets; (v) one or more quadrupole, hexapole, octapole or higher order rod sets; or (vi) a plurality of electrodes having apertures through which ions are transmitted in use.

26. A mass spectrometer as claimed in claim 1, wherein the magnitude of said first electric field varies with time whilst ions pass through said first electric field region.

27. A mass spectrometer as claimed in claim 26, wherein the magnitude of said first electric field increases with time.

28. A mass spectrometer as claimed in claim 26, wherein the magnitude of said first electric field decreases with time.

29. A mass spectrometer as claimed in any of claims 26, wherein the magnitude of said first electric field

varies substantially sinusoidally or cosinusoidally with time.

30. A mass spectrometer as claimed in claim 26, wherein the magnitude of said first electric field varies substantially exponentially with time.

31. A mass spectrometer as claimed in claim 26, wherein the magnitude of said first electric field varies substantially: (i) linearly with time; (ii) according to a square law ramp function with time; (iii) according to a cubic law ramp function with time; (iv) according to a power law ramp function with time; (v) according to a quadratic or higher order polynomial function with time; or (vi) according to a multiple stepped function with time.

32. A mass spectrometer as claimed in claim 1, wherein the direction of said first electric field is in a direction substantially parallel to the direction of ion travel.

33. A mass spectrometer as claimed in claim 1, wherein the direction of said first electric field changes whilst ions pass through said first electric field region.

34. A mass spectrometer as claimed in claim 1, wherein the length of said first electric field region is selected from the group consisting of: (i) < 1 mm; (ii) 1-2 mm; (iii) 2-3 mm; (iv) 3-4 mm; (v) 4-5 mm; (vi) 5-6 mm; (vii) 6-7 mm; (viii) 7-8 mm; (ix) 8-9 mm; (x) 9-10 mm; and (xi) > 10 mm.

35. A mass spectrometer as claimed in claim 1, wherein said first electric field acts to decelerate at least some of said ions passing through said first electric field region.

36. A mass spectrometer as claimed in claim 1, wherein said first electric field acts to accelerate at least some of said ions passing through said first electric field region.

37. A mass spectrometer as claimed in claim 1, further comprising a first field free region arranged downstream of said first electric field region.

38. A mass spectrometer as claimed in claim 37, wherein said first field free region is formed by one or more tubular electrodes and/or one or more plate electrodes.

39. A mass spectrometer as claimed in claim 37, wherein the length of said first field free region is selected from the group consisting of (i) $\leq$ 50 mm; (ii) $\geq$ 50 mm; (iii) $\geq$ 100 mm; (iv) $\geq$ 150 mm; (v) $\geq$ 200 mm; (vi) $\geq$ 250 mm; (vii) $\geq$ 300 mm; (viii) $\geq$ 350 mm; (ix) $\geq$ 400 mm; (x) $\geq$ 450 mm; and (xi) $\geq$ 500 mm.

40. A mass spectrometer as claimed in claim 37, further comprising a collision or fragmentation cell arranged in said first field free region.

41. A mass spectrometer as claimed in claim 40, wherein said collision or fragmentation cell comprises a tubular housing.

42. A mass spectrometer as claimed in claim 40, wherein ions are not confined radially within said collision or fragmentation cell by pseudo-potential wells.

43. A mass spectrometer as claimed in claim 40, wherein no AC or RF voltages are applied to said collision or fragmentation cell in order to provide radial confinement of ions.

44. A mass spectrometer as claimed in claim 40, further comprising an electrostatic energy analyser and/or mass filter and/or ion gate arranged upstream of said collision or fragmentation cell.

45. A mass spectrometer as claimed in claim 40, further comprising an electrostatic energy analyser and/or mass filter and/or ion gate arranged downstream of said collision or fragmentation cell.

46. A mass spectrometer as claimed in claim 44, wherein said mass filter comprises a magnetic sector mass filter, an RF quadrupole mass filter or a Wien filter.

47. A mass spectrometer as claimed in claim 1, further comprising a second electric field region arranged upstream of said first electric field region wherein in use a second electric field is maintained across at least a portion of said second electric field region.

48. A mass spectrometer as claimed in claim 47, wherein said second electric field remains substantially

constant with time whilst ions pass through said second electric field region.

49. A mass spectrometer as claimed in claim 47, wherein said second electric field causes at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95% or substantially 100% of ions passing through said second electric field region to exit said second electric field region with substantially the same kinetic energy.

50. A mass spectrometer as claimed in claim 47, wherein whilst ions pass through said second electric field region a potential difference is maintained across at least a portion of said second electric field region selected from the group consisting of: (i) < 50 V; (ii) 50-100 V; (iii) 100-150 V; (iv) 150-200 V; (v) 200-250 V; (vi) 250-300 V; (vii) 300-350 V; (viii) 350-400 V; (ix) 400-450 V; (x) 450-500 V; (xi) 500-600 V; (xii) 600-700 V; (xiii) 700-800 V; (xiv) 800-900 V; (xv) 900-1000 V; (xvi) 1-2 kV; (xvii) 2-3 kV; (xviii) 3-4 kV; (xix) 4-5 kV; and (xx) >5 kV.

51. A mass spectrometer as claimed in claim 47, wherein the length of said second electric field region is selected from the group consisting of (i) < 1mm; (ii) 1-2 mm; (iii) 2-3 mm; (iv) 3-4 mm; (v) 4-5 mm; (vi) 5-6 mm; (vii) 6-7 mm; (viii) 7-8 mm; (ix) 8-9 mm; (x) 9-10 mm; and (xi) > 10 mm.

52. A mass spectrometer as claimed in claim 47, wherein said second electric field is varied with time whilst ions pass through said second electric field region.

53. A mass spectrometer as claimed in claim 1, further comprising a second field free region arranged upstream of said first electric field region.

54. A mass spectrometer as claimed in claim 47, further comprising a second field free region arranged between said first electric field region and said second electric field region.

55. A mass spectrometer as claimed in claim 53, wherein said second field free region is formed by one or more tubular electrodes and/or one or more plate electrodes.

56. A mass spectrometer as claimed in claim 53, wherein at least some of the ions passing through said second field free region become spatially and/or temporally separated according to their mass to charge ratio.

57. A mass spectrometer as claimed in claim 53, wherein the length of said second field free region is selected from the group consisting of (i) < 10mm; (ii) 10-20 mm; (iii) 20-30 mm; (iv) 30-40 mm; (v) 40-50 mm; (vi) 50-60 mm; (vii) 60-70 mm; (viii) 70-80 mm; (ix) 80-90 mm; (x) 90-100 mm; and (xi) > 100 mm.

58. A mass spectrometer as claimed in claim 1, further comprising an axial DC acceleration lens arranged upstream of said extraction or acceleration region.

59. A mass spectrometer as claimed in claim 1, wherein said extraction or acceleration region has a length selected from the group consisting of: (i) < 1 mm; (ii)

1-2 mm; (iii) 2-3 mm; (iv) 3-4 mm; (v) 4-5 mm; (vi) 5-6 mm; (vii) 6-7 mm; (viii) 7-8 mm; (ix) 8-9 mm; (x) 9-10 mm; and (xi) > 10 mm.

60. A mass spectrometer as claimed in claim 1, wherein the axial length of said extraction or acceleration region is adjustable.

61. A mass spectrometer as claimed in claim 1, wherein said extraction or acceleration region comprises a plurality of extraction or acceleration electrodes.

62. A mass spectrometer as claimed in claim 61, wherein in use the effective length of said extraction or acceleration region is adjusted by varying the number extraction or acceleration electrodes used to extract or accelerate ions.

63. A mass spectrometer as claimed in claim 1, further comprising an adjustable aperture, shutter or beam stop arranged between an extraction or acceleration electrode arranged in said extraction or acceleration region and a drift or flight region arranged downstream of said extraction or acceleration region, wherein in a mode of operation said adjustable aperture, shutter or beam stop substantially prevents or attenuates at least some ions which have been extracted or accelerated by said extraction or acceleration electrode from being transmitted into said drift or flight region.

64. A mass spectrometer as claimed in claim 63, wherein the size, area, diameter, length, width or transmission

coefficient of said aperture, shutter or beam stop is adjustable.

65. A mass spectrometer as claimed in claim 63, wherein at least some parent ions are fragmented in use in a fragmentation or collision cell into fragment ions and wherein fragment ions and their corresponding parent ions exit said fragmentation or collision cell with substantially the same velocity and reach said extraction or acceleration electrode at substantially the same time.

66. A mass spectrometer as claimed in claim 63, wherein in said mode of operation multiple parent ions having different mass to charge ratios and their corresponding fragment ions are extracted or accelerated into said drift or flight region at the same time and wherein said adjustable aperture, shutter or beam stop substantially prevents or attenuates at least some parent ions and their corresponding fragment ions from being transmitted into said drift or flight region whilst substantially permitting or transmitting at least some other parent ions and their corresponding fragment ions into said drift or flight region.

67. A mass spectrometer as claimed in claim 1, further comprising an ion source selected from the group consisting of: (i) an Electrospray ("ESI") ion source; (ii) an Atmospheric Pressure Chemical Ionisation ("APCI") ion source; (iii) an Atmospheric Pressure Photo Ionisation ("APPI") ion source; (iv) a Laser Desorption Ionisation ("LDI") ion source; (v) an Inductively Coupled Plasma ("ICP") ion source; (vi) an Electron

Impact ("EI) ion source; (vii) a Chemical Ionisation ("CI") ion source; (viii) a Field Ionisation ("FI") ion source; (ix) a Fast Atom Bombardment ("FAB") ion source; (x) a Liquid Secondary Ion Mass Spectrometry ("LSIMS") ion source; (xi) an Atmospheric Pressure Ionisation ("API") ion source; and (xii) a Field Desorption ("FD") ion source.

68. A mass spectrometer as claimed in claims 1, further comprising a Matrix Assisted Laser Desorption Ionisation ("MALDI") ion source.

69. A mass spectrometer as claimed in claim 1, further comprising a Desorption/Ionisation on Silicon ("DIOS") ion source.

70. A mass spectrometer as claimed in claim 1, further comprising a continuous ion source.

71. A mass spectrometer as claimed in claim 1, further comprising a pulsed ion source.

72. A mass spectrometer as claimed in claim 1, wherein said Time of Flight mass analyser comprises an orthogonal acceleration Time of Flight mass analyser.

73. A mass spectrometer as claimed in claim 1, wherein said Time of Flight mass analyser comprises an axial acceleration Time of Flight mass analyser.

74. A method of mass spectrometry comprising:
providing a first electric field region;

providing a Time of Flight mass analyser comprising an extraction or acceleration region; and

varying a first electric field applied across at least a portion of said first electric field region such that ions having substantially different mass to charge ratios passing through said first electric field region are accelerated and/or decelerated such that ions having substantially different mass to charge ratios arrive at said extraction or acceleration region at substantially the same time.

75. A method as claimed in claim 74, wherein the magnitude of said first electric field varies with time whilst ions pass through said first electric field region.

76. A method as claimed in claim 74, wherein the magnitude of said first electric field increases with time.

77. A method as claimed in claim 74, wherein the magnitude of said first electric field decreases with time.

78. A method as claimed in claim 74, wherein the magnitude of said first electric field varies substantially sinusoidally or cosinusoidally with time.

79. A mass spectrometer comprising:

a fragmentation or collision cell;

a Time of Flight mass analyser comprising an extraction or acceleration electrode and a drift or flight region, wherein said extraction or acceleration

electrode extracts or accelerates ions in use into said drift or flight region; and

an adjustable aperture, shutter or beam stop arranged between said extraction or acceleration electrode and said drift or flight region, wherein in a mode of operation said adjustable aperture, shutter or beam stop substantially prevents or attenuates at least some ions which have been extracted or accelerated by said extraction or acceleration electrode from being transmitted into said drift or flight region.

80. A mass spectrometer as claimed in claim 79, wherein the size, area, diameter, length, width or transmission coefficient of said aperture, shutter or beam stop is adjustable.

81. A mass spectrometer as claimed in claim 79, wherein at least some parent ions are fragmented in use in said fragmentation or collision cell into fragment ions and wherein fragment ions and their corresponding parent ions exit said fragmentation or collision cell with substantially the same velocity and reach said extraction or acceleration electrode at substantially the same time.

82. A mass spectrometer as claimed in claim 79, wherein in said mode of operation multiple parent ions having different mass to charge ratios and their corresponding fragment ions are extracted or accelerated into said drift or flight region at the same time and wherein said adjustable aperture, shutter or beam stop substantially prevents or attenuates at least some parent ions and their corresponding fragment ions from being transmitted

into said drift or flight region whilst substantially permitting or transmitting at least some other parent ions and their corresponding fragment ions into said drift or flight region.

83. A method of mass spectrometry comprising:

providing a fragmentation or collision cell, a Time of Flight mass analyser comprising an extraction or acceleration electrode and a drift or flight region, and an adjustable aperture, shutter or beam stop arranged between said extraction or acceleration electrode and said drift or flight region;

extracting or accelerating ions into said drift or flight region; and

using said adjustable aperture, shutter or beam stop to substantially prevent or attenuate at least some ions which have been extracted or accelerated by said extraction or acceleration electrode from being transmitted into said drift or flight region.